Ideas on Innovation

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HOW MANY JOBS?

The impact of technological change on new job creation

Traditionally, assembly of finished goods and the processing of financial information have been mainstays of the Ontario economy. Jobs in these sectors are particularly vulnerable to expanded use of automatic machines and computers. To many workers, therefore, the effect of technological change is a growing and disquieting issue.

Most economists, and many industrialists, have been examining the past to forecast the future. They suggest that the economy will adjust to new technology: jobs will be created in new industries and production in existing firms will increase sufficiently to result in a higher net employment level.

Other, less sanguine analysts question such forecasts:

Have they fully accounted for the profoundly new technologies?

Have they accounted for speed of introduction?

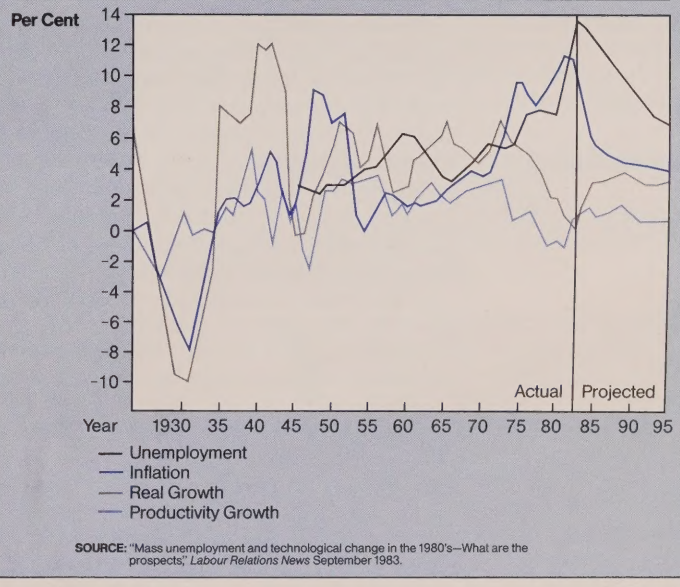
Under what circumstances, and to what degree, is technological change a force in job creation or job elimination?

What can be done to minimize disruption in the existing labor market?

To delve into such questions, IDEA commissioned Dr. Arthur Younger to conduct experiments using the FOCUS model developed and maintained under the University of Toronto's Policy and Economic Analysis Program (PEAP). Younger's study explored how the adoption of new technologies might affect jobs and economic policy in Canada. He extended his earlier work on the development of *new* high-tech industries to include the application of new high-tech products in *existing* industries.[1] This approach is based on data collected from high-technology firms, and tests how federal economic policy might influence the impact of technological change on employment levels.

Younger's findings are briefly reviewed in this issue of "Ideas on Innovation."

PRODUCTIVITY GROWTH AND ECONOMIC PERFORMANCE



SOURCE: "Mass unemployment and technological change in the 1980's—What are the prospects," *Labour Relations News* September 1983.

Chart 1

THE CANADIAN RECORD

By definition, technological progress helps increase productivity. Remarkably, in recent Canadian history, it appears that high labor productivity (which reflects rapid technological change) has regularly coincided with low unemployment and high output growth *(Chart 1)*.

From the late '50s through to the early '70s, for example, Canadian productivity rose in step with employment – for good economic reasons. One analyst describes it this way: "The 1930s was a period of significant technological innovation – new drugs, plastics, electronics, even nuclear physics – but the innovations

"If Canada does not use new technologies, other countries will, and the job loss in Canada will then be far greater."

Walter Light, Chairman and Chief Executive Officer, Northern Telecom

were not exploited in production until *after* World War II, in a healthier economic climate with lower unemployment."[2]

Strong parallels are evident in the current economic recovery. Despite spectacular scientific discoveries, Canadian business investment, including the purchase of new technology, has lagged in the face of high unemployment and volatile demand *(Chart 2)*.

There is another reason why rapid technological change in the past has not been accompanied by rising unemployment. When labor enters a period of excess supply, as in the past two years, it eventually lowers its asking price. In turn, when labor is "cheap" and new investment is risky, firms have much less incentive to substitute new machinery for labor.

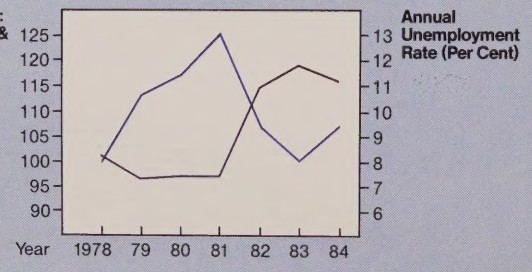
The reverse is also true: labor scarcity, marked by low unemployment, strengthens labor's bargaining position, raises wages and makes labor-saving technology more attractive. This has been the case in Japan where a foreseeable shortage of workers (occasioned by an aging population) has been a major impetus behind automation.

Chart 2

REAL BUSINESS INVESTMENT AND UNEMPLOYMENT RATES

Data:

Year:	1978	1979	1980	1981	1982	1983	1984
Bus. M & E:	100	113	117	125	107	100	107
Unemployment Rate:	8.3	7.4	7.5	7.5	11.0	11.9	11.3



— Real Business Investment: Business Machinery & Equipment.
— Unemployment Rate.

SOURCE: Statistics Canada
(1984 unemployment rate seasonably adjusted rate for 1984:1); forecast for 1984 real business investment from Currie, Coopers and Lybrand

MODELS OF TECHNOLOGICAL CHANGE

But this is not the whole story. There are four fundamental questions that need to be answered:

Does technological change eventually increase employment?
If so, how long do we have to wait?
How many jobs might be temporarily displaced?
What economic policies will reduce the disruption period or minimize job displacement?

To answer these questions, the likely dynamic adjustment pattern of the whole economy to technological progress must be studied. One tool, for this kind of study, is an econometric forecasting model such as FOCUS.

In fact, several experiments using forecasting models already have been conducted in industrialized economies. Typically, they *do* predict an eventual rise in employment. Jobs lost in automating industries are more than offset by jobs created in other industries.

In particular, two previous studies – by Chase Econometrics and Informetrica – have attempted to model technological change in Canada by raising the level of productivity over the forecast period. They agree that little change in net employment is expected by the mid-1990s. While direct dislocation is temporarily significant, the dynamic response of the economy to greater efficiency and competitiveness restores the total number of jobs in 10 to 15 years.

Chase Econometrics found that "an increase in the average level of efficiency leads to an increase in output and little change in employment."[3]

Similarly, Informetrica calculates that if labor productivity grew by 0.25% annually, 400,000 jobs directly affected by greater efficiency might disappear by the year 2000.

However, this loss would be offset by jobs created indirectly in a larger economy with a rising real income.[4]

NEW EXPERIMENTS WITH FOCUS

Younger's approach, using the FOCUS model, differs from that of Chase and Informetrica. Instead of simulating technological change by arbitrarily adjusting productivity upward, Younger has constructed a more complex model of technical upgrading based on available estimates of production requirements (capital and labor) of existing high-tech companies.

He has simulated two facets of technical progress on FOCUS. First, the size of the current high-tech sector (excluding Northern Telecom) has been doubled. This $2 billion addition is "built" between 1984 and 1987 and reaches full production and employment of 34,000 people in 1990. It has all the characteristics of the existing Canadian high-tech industry: high average wages, efficient use of capital, equipment and labor in production and a relatively low capital/labor ratio.

Second, part of the production of these new high-tech industries has been diffused, primarily into existing "older" Canadian industries in the form of new machinery and equipment to modernize production. This gradual modernization, which *raises* the capital/labor ratio, is the real object of fears about job loss or dislocation.

Younger's technological change experiment has been conducted under three different macroeconomic policy settings to assess the sensitivity of employment outcome to traditional economic levers. The settings vary the growth of the domestic money supply (**monetary policy**); the value of Canadian currency in U.S. funds (**exchange rate policy**); price levels and wage bargaining procedures (**incomes policy**); and import content

Economist Arthur Younger

of purchased technology goods (**industrial policy**).

By adjusting these levers, Younger has found that employment growth is most rapid if:

- The money supply is expanded to offset exchange-rate pressures caused by foreign sales of high-tech products.
- Wage bargaining behavior is modified to allow cost savings from higher productivity to be "passed through" more quickly into lower consumer prices. This requires a broader consensus between bargaining sectors, along with supportive policies to ensure labor adjustment and labor retraining.
- Canadian high-tech industries can supply virtually all the needs of other Canadian industry for new equipment (i.e. low import penetration).

In such a setting, net job creation in Canada is strong throughout the 1990s, principally because the overall rate of economic expansion is strong *(Chart 3)*. This outlook is extremely

"New technology must be introduced only as part of a national strategy which accounts for both social and economic effects."

Canadian Labour Congress[5]

optimistic and serves only as a benchmark of what *could* happen in the best possible world.

By contrast, employment levels are lowest in Younger's forecasts if the Bank of Canada, favoring lower inflation over higher economic growth, pursues a restrictive monetary policy. This policy fails to relieve the upward pressure on the exchange rate caused by the rising productivity that permitted strong export performance. In order to reduce inflation, a higher Canadian dollar is allowed to inhibit the competitiveness of domestic industry and, consequently, output and employment growth are slowed. This scenario reveals the crucial policy trade-off between reducing inflation and increasing real growth.

The plausible middle course for job creation, in Chart 3, depends solely on monetary policy. If the Bank of Canada were to expand the money supply to keep the Canadian dollar from appreciating strongly, additional growth would result, though inflation would not be improved. Nor would inflation be reignited, however, since improved productivity itself dampens price rises. As a result, interest rates fall while total economic activity and employment grow fairly strongly. It is important to note that this supposes no special modification of wage behavior in the economy, so productivity cost savings affect price and wage levels at the normal rate.

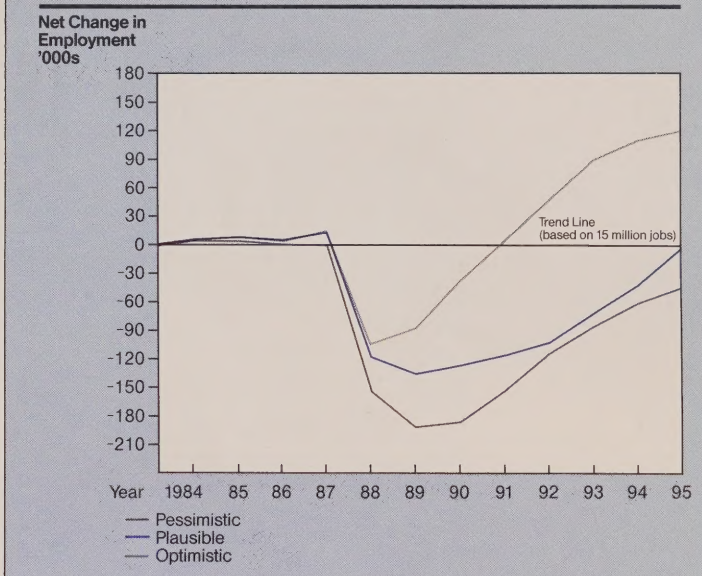
In assessing Younger's projections, it is important to remember that Canada's trading partners also will be adopting new technology and thereby raising *their* productivity. This reduces the net gain to Canada of a given rate of technical progress at home. On the other hand, observers anticipate a rapid growth of international demand for high-tech products. Younger's simulations did not incorporate any assumptions about market growth. Thus, they tend to understate the potential growth opportunities offered by technological change.

Likewise, import-competing industries are more vulnerable and are compelled to incorporate new technologies to maintain their competitiveness.

NET IMPACT ON EMPLOYMENT TRENDS OF $2 BILLION GROWTH IN HIGH-TECH SECTOR

Data:

Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Pessimistic	3	3	1	1	-152	-190	-183	-151	-115	-85	-60	-43
Plausible	5	7	3	12	-119	-136	-126	-117	-100	-70	-40	-2
Optimistic	6	9	5	16	-102	-87	-36	6	49	92	113	121



SOURCE: A. Younger Simulations on FOCUS, University of Toronto 1983

Chart 3

SHARING THE WEALTH

Any increase of efficiency in making new products or using new methods of production will create additional income: a "productivity dividend." This income can be distributed in different ways: to wage earners (higher real wages); to the investing firm (higher profits); to the consumer (lower prices); or to governments (increased tax revenues). The FOCUS model shows strong recovery in corporate profits in all three scenarios.

"In the long run, the growth rate of output per head depends on the rate of technological change (improvements in the methods of production)."

Rüdiger Dornbusch[6]

However, profits of the new-technology firms, established between 1984 and 1987, remain comparatively low over the forecast period. Low profitability of new high-tech industries is evidently caused by their high wage bill. A relative shortage of skilled scientific and engineering personnel permits this group to command a very high average wage. As the supply of specialized labor gradually expands, we can expect the pressure on wages to be reduced. Thereafter, profits for new high-tech industries improve and new firms entering into the subsequent round of new-tech expansion can anticipate earlier profitability.

This development in Younger's simulation reveals the importance of manpower policy to the success of Canadian technology industries and their investors. Low profitability will deter investment and the subsequent expansion of this key sector.

(To help avoid bottlenecks in the labor market and maintain investor interest in high-tech industries, IDEA is collaborating with the Ontario Manpower Commission to identify emerging and critical occupations in these sectors for government, industry and educational training institutions.)

Younger also finds that economic expansion is strongest (and jobs most plentiful) if the additional income from higher productivity is transferred to consumers through a general reduction in prices. In those industries with few producers (and possibly benefitting from import controls), however, the consumer may not receive the maximum gains from technology. Rather, "in a monopolized industry, the remaining workers would receive some of the gain in higher wages, but a large proportion would be directed to corporate profits, some parts of which might be captured by governments through taxes."[7]

This situation is particularly important for Canada where production in major industries such as autos, steel, primary textiles, machinery, food and electronics is dominated by a few firms that, in many cases, are foreign-owned. In these circumstances, there is a risk that some of the gain from introducing new technology will flow in dividends to U.S. corporate parents, thus minimizing the stimulus from higher productivity on indirect job generation. This risk signals the need to maintain an open and competitive trading environment in Canada, and to develop a compelling investment climate for multinationals.

REINVESTING THE PRODUCTIVITY DIVIDEND

Younger's experiment also strongly suggests that monetary policy is fundamental to long-term labor market expansion throughout the technological revolution. Canada's construction of a larger high-tech sector, along with technological upgrading of existing industry, is likely to improve the overall trade position significantly and, in turn, put upward pressure on the Canadian dollar. (The amount of pressure depends, in part, on whether other countries do the same.)

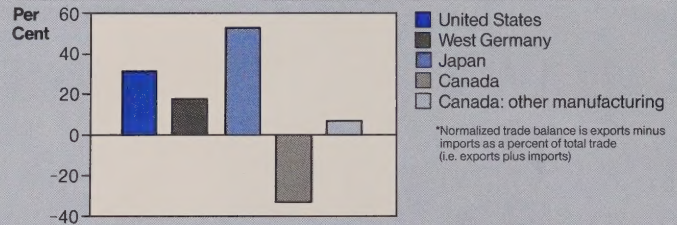
In the simulations, a rise in the Canadian dollar lowers inflation but stifles economic expansion. The Bank of Canada could control the rise of the Canadian currency by relaxing its money supply targets, thereby encouraging economic expansion. Younger found that an accommodation of technology policy by the monetary authorities, which would maintain the exchange rate at its current level, was clearly effective in reducing short-term job loss due to technological upgrading in existing firms.

Technological upgrading gives us some badly needed room to manoeuvre on economic policy because of the productivity dividend. This dividend can be used to raise the value of the Canadian dollar, reduce prices or raise the rate of economic growth and job creation. In view of anticipated rates of economic growth and relatively low inflation in the mid-1980s, the latter option for monetary policy is attractive.

NORMALIZED TRADE BALANCE*
IN HIGH TECHNOLOGY PRODUCTS:
CANADA RELATIVE TO OTHER COUNTRIES 1981

Data:

United States	30%	Canada high-tech	-34%
West Germany	18%	Canada: other manufacturing	6%
Japan	54%		



*Normalized trade balance is exports minus imports as a percent of total trade (i.e. exports plus imports)

SOURCE: U.S. Department of Commerce, International Trade Administration

Chart 4

CREATING JOBS WITH HOME-GROWN TECHNOLOGY

Technology is increasingly important in the expansion or modernization of industrial capacity. For example, U.S. statistics indicate that high-technology equipment represents about half of business investment in the early 1980s, up from about 15% in the 1950s.

Canada's trade position in technical equipment has been weak compared to other sectors in the economy and against other industrialized countries *(Chart 4)*. Canada's job prospects are best if industry tries to meet all our needs for technical equipment. That way, our economy captures more of the wealth produced by the drive to higher productivity.

In considering industrial strategies to correct the trade imbalance in technology, policy-makers must recognize, however, that Canadian trade in technology is characterized by both a high volume of exports as well as imports – reflecting the specialization of international production and markets. In this context, effective import substitution probably will not be achieved across a wide range of equipment and products, but rather by promoting exports from industries where Canada has a niche or comparative advantage.

ACCEPTING CHANGE

There is one final consideration in dealing with the impact of technological change on the Canadian labor market. As noted earlier, in these simulations the number of jobs was at its highest when the benefits from productivity were transferred rapidly to lower prices (as opposed to higher corporate profits or direct wages). This means that policies encouraging the "passing through" of the productivity dividend are important. Toward this end, measures that facilitate adaptability in labor markets, such as increased mobility allowances to allow displaced workers to move to new jobs, business start-up incentives and market-oriented training programs, could positively influence the outcome of the technology/jobs issue.

Many submit that the technological era will require most Canadians to retrain many times during their working life. Policies that expedite this continuous education, and shift of labor from one sector to another, will influence the acceptance of technology and, in turn, its impact on the overall level of employment.

IN CONCLUSION

Younger's work confirms what previous forecasters have argued: technological change eventually does lead to new job creation. Temporary dislocations can be minimized and new job creation can be ensured in the future... if we play our cards right today.

FOOTNOTES

[1] A. Younger, *Modelling New Industries in FOCUS*, April 1983, unpublished.
[2] P. Dungan, "Mass Unemployment and Technological Change in the 1980s – What are the Prospects?", *Labour Relations News*, September 1983.
[3] Chase Econometrics, *The Impact of Microelectronics on Employment and Economic Growth in the 1980s*, July 1981.
[4] Informetrica (M.C. McCracken), "Technology, Labour Markets and the Economy", paper presented to the Canada Tomorrow Conference, 1983.
[5] Canadian Labour Congress, *Technological Change and Work*, 1982.
[6] R. Dornbusch, *Macroeconomics*, p. 456.
[7] Informetrica, op. cit., p. 6.

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